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ALEXANDRIA FIELD OFFICE

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EVALUATION OF COTTONWOOD DECLINE AND MORTALITY IN THE RIPARIAN WOODLAND OF THE BEAVER RIVER IN TEXAS COUNTY, OKLAHOMA, 1981

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EVALUATION OF COTTONWOOD DECLINE AND MORTALITY IN THE RIPARIAN WOODLAND OF THE BEAVER RIVER IN TEXAS COUNTY, OKLAHOMA, 1981

by

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ABSTRACT

A survey of 150 miles of riparian woodland along the Beaver River and its tributaries in Texas County, Oklahoma, was conducted to determine the extent and cause of cottonwood decline and mortality. Twenty-two percent of the cottonwood trees are dead or dying. Decline and mortality occurred more frequently in the 1-10" dbh size class and in geographic pockets or stretches of the river. No insect or disease problems appear responsible. The decline is primarily the result of severe and long-term moisture stress from the alteration and lowering of groundwater levels by irrigation wells.

INTRODUCTION

The riparian woodland of the Great Plains is extremely valuable for wildlife habitat, recreation and the aesthetic contrast it provides to the surrounding region. Cottonwood (Populus deltoides, L.) is the predominant forest tree, often being found in nearly pure stands. Other associates are willow, boxelder, green ash, siberian elm, hackberry and salt cedar. Such habitats have been the subject of some interest in recent years (Great Plains Agric. Counc., 1979).

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During the summer of 1978 a progressive dying of many of the cottonwood trees along the Beaver River and its tributaries in Texas, Beaver and Cimarron Counties of western Oklahoma became obvious. USDA Forest Service personnel from the Rocky Mountain Forest and Range Experiment Station and the Forest Pest Management Field Office, Pineville, LA, have visited this area with personnel of the Oklahoma Forestry Division and Oklahoma State University. No insect or disease problem was observed, with the exception of a fungus, Cytospora sp., which was found associated with cankering on dying tees. This fungus, while associated with the mortality, is normally considered a secondary pathogen, incapable of killing healthy trees (USDA For. Serv., 1972).

Irrigation of agronomic crops such as alfalfa, corn, sorghum and wheat from water wells has increased dramatically since 1963 in the area around Guymon, Oklahoma, (Okla. Water Resour. Board, 1973). Many of these new irrigation wells tap the relatively deep Ogallala aquifer which underlies large areas of western Texas, Oklahoma, Kansas, and Nebraska. Other wells near the Beaver River tap the relatively shallow alluvium which is more directly associated with the surface water of the river. Most irrigation wells show an increase in depth to water each year. This alteration of the existing ground water supply may be affecting the health and longevity of riparian woodland.

Landowner concern and the confusing nature of the problem resulted in a specific request from the Oklahoma Forestry Division for a survey to determine the extent, severity and possible cause(s) of the problem, and to make any recommendations possible to aid in alleviating future losses.

METHODS

The Alexandria Field Office, Forest Pest Management in cooperation with the Oklahoma Forestry Division and with the support of the OSU Extension Service conducted a survey along the Beaver (N. Canadian) River and its tributaries in Texas County, Oklahoma, in June 1981. Sixty-three, 10-tree plots were predetermined on maps at approximately 2 mile intervals along the Beaver River, Coldwater Creek, Frisco Creek, Palo Duro Creek and Goff Creek. Sample plots were located along approximately 150 linear miles of waterway (figure 1). Since gaps in the timber occur along the streams, some plots were moved to accessible wooded areas near the predetermined plot location.

Height to nearest foot and diameter to nearest inch were recorded for each of 10 cottonwood trees closest to the plot center. Each tree was rated for crown condition (table 1) and presence or absence of cankers (table 2). Presence of insects, fungi or other damaging agents were noted as appropriate.

Soil was sampled to a minimum of 6 and a maximum of 12 inches deep at every 5th plot beginning with plot #3. If no trees were present, samples were taken at the next plot. Soil samples were a composite of 3-5 cores taken with a soil probe. Paired samples were collected from under healthy trees (crown rating 3) and dead or dying trees (crown rating 0 or 1). Soil analysis was performed by the Soils Laboratory at Oklahoma State University.

Samples of bole or branch cankers and fungal fruiting structures were gathered from dying or cankered trees at 13 plots. Laboratory analysis of these samples was made by Forest Pest Management, Alexandria Field Office.

The locations and water level records of 15 wells in Texas County nearest the survey area (as monitored by the US Geological Survey) were obtained from the Oklahoma Water Resources Board.

RESULTS

The cottonwood trees along the Beaver River are beginning to die out. Forty-one percent of the 63 plots had mean crown ratings of 2 or less (dead and dying) and 40% had mean canker ratings of 2-7 (seriously cankered) (table 3). When the trees are considered individually, 22% had crown ratings of 0 or 1, and 31% had canker ratings of 2-7 (table 4). Therefore, the declining portion of the cottonwood population is in the range of 22-41% depending on the standard. In addition, very little cottonwood regeneration was seen. The 1-2" and 3-4" size classes account for only about 4% of the population (figure 2).

Tree crown ratings and canker ratings were significantly correlated. Seventy-seven percent of the trees with crown ratings of 0 or 1 (declining and dead) also had canker ratings of 2-7 cankered. However, only 56% of trees rated as cankered (2-7) also had declining crowns (0 or 1). Therefore, the former relationship appears to represent a stronger association. Similarly, of 28 plots with either a mean crown rating of <2 or a mean canker rating of >2, 61% had both (table 5). The remaining 39% of these plots had only one or the other rating. Thus, while commonly occurring together, both crown dieback and cankering occurred independently of one another.

Crown and canker ratings were each significantly correlated to dbh when trees were grouped in 10" dbh classes (figure 3). Dead and dying trees (crown rating 0 or 1) and seriously cankered trees (canker rating 2-7) occurred most often in the 1-10" dbh group. It contained 50 and 44%, respectively, of these dead or dying trees, although this class accounted for only 37% of all trees. Neither crown nor canker ratings correlated with tree height.

Decline and mortality were not uniformly distributed over the sample area. Statistical analysis indicated that crown decline and cankering were associated with groups or clusters of plots; i.e., decline and mortality were present mainly in geographic pockets or stretches of trees. This is apparent when observing the actual location of plots with either a mean crown rating of <2 or a mean canker rating >2 (figure 1). Seventy-seven and 80%, respectively, of these plots occurred in geographic succession of 2 or more plots, while only 23 and 20%, respectively, occurred as solitary plots (table 6). Plots 8, 27 and 29 were omitted from the above analysis due to known factors such as herbicide drift and construction of the Optima Reservoir.

Seven genera of fungi plus several unknowns were isolated from stem and branch cankers on cottonwood trees. These are listed in table 7 along with the frequency of isolation. Cytospora sp. was the most frequently isolated fungus, but it only accounted for 31% of the isolations. Cytospora sp. fruiting structres were occasionally found. Other isolated fungi represent either commonly occurring saprophytic fungi or fungi of possible but unknown pathogenicity. Cambial death and sapwood staining were present in most cankers (figure 4). No serious insect infestations were observed during the survey. Evidence of grazing by cattle was present and heavy in many sampled stands.

Results of the soil sample analysis are presented and discussed in Appendix I. In general, no significant differences were found between soil associated with dead/dying and healthy trees. The soils are alluvial sands and gravels, well drained, susceptible to drought and dependent on surface and sub-surface river flow for infusion of moisture. Rainfall and accumulated runoff moves rather quickly through the soil profile except during times of flooding which are infrequent.

Precipitation and water well level data are presented and discussed in Appendix II. Precipitation in western Oklahoma (Goodwell) averages about 16.94" annually, a semi-arid climate. Rainfall is characteristically unpredictable in amount and frequency of occurence. Table 2, Appendix II indicates that dry years occurred in 1974-1976 and again in 1980. Water levels in selected irrigation wells for the period 1966-1980 are presented in table 1 and figure 1, Appendix II. Nine of the 12 Texas County wells tapping the Ogallala aquifer show significant and steady declines in water level. Three remained about the same with minor fluctuations. Wells tapping the shallow alluvium showed less overall change but often fluctuated dramatically from year to year. Well readings are generally made in January when water levels have made maximum recovery from the drawdown during pumping season. Average decline in the Ogallala wells for the 14 year period was 18.9 feet and for the alluvial wells 2.28 feet. Average depth to water in 1980 was 141.4 and 17.0 feet, respectively.

DISCUSSION

It is difficult to determine the precise cause for the general decline and dieout of timber which is occurring in western Oklahoma. No major insect pests were discovered and the variety of fungi isolated from dying and cankered trees suggests that no single pathogen is involved. That Cytospora was most frequently isolated further confirms it as a canker causing fungus of weakened or stressed cottonwood trees (USDA For. Serv., 1972), but it was not prevalent enough to implicate it as the primary cause of decline. Also, the relationship of serious cankering to heavy crown dieback appears stronger than the reverse relationship indicating that crown decline may be occurring prior to serious cankering.

The greatest amount of mortality having occurred in the 1-10" dbh class further suggests that a pathogen is not primarily responsible since young, vigorous trees are better able to withstand attacks by the weak pathogens

isolated. In the absence of stress factors, fungi such as Cytospora should do their greatest damage on overmature, non-vigorous trees. Soil problems can also be eliminated as a factor in the decline; analysis indicated that no real differences are present between soil associated with healthy or declining/dead trees.

The cottonwood decline appears to be due to major stress factors operating over a large area and time span. The most obvious is moisture stress from drought and the lowering of the water table in the area. Cottonwood on the high plains is confined exclusively to river and creek bottoms where a moisture supply is available from subirrigation and periodic runoff. The unpredictable rainfall of the area alone is insufficient to sustain cottonwood growth for very many years. Cottonwood generally requires a site not more than 8 to 12 feet above the water table and requires a moist, bare seedbed for regeneration (Folwells, 1965). The sandy alluvial soils on which it normally occurs are very well drained, prevalent to drought and dependent on surface and sub-surface river flow for infusion of moisture. Cottonwood, therefore, is truly riparian. Its overall growth, health and reproduction is directy tied to the available moisture of a water course.

The most serious alteration of the water supply in this area is being caused by irrigation wells tapping the shallow alluvium. This water is associated almost directly with the river. The 17' average depth to water of the three alluvial wells is considerably deeper than the 8 to 12 foot depth for cottonwood defined by Folwells. The average 2.28 foot drop in level indicates that a good deal of the available moisture has recently been diverted from the river. Local residents also mentioned that surface flows in creeks and rivers have diminished in past years. Well readings taken in January are maximum levels, occurring when cottonwoods are dormant and have a minimum need for water. During the pumping season, irrigation wells create a cone or depression in the water table and closely spaced wells may cause sudden drops in water levels in excess of the recorded 2.28 feet at a time when transpirational needs of cottonwood are the greatest (Okla. Water Resour. Board, 1973). This would obviously place great stress on the trees and could cause dieback and death if repeated over time. The geographic "pockets" of declining timber we observed on the river suggest that this is happening in many areas and is associated with such localized reductions in the water level. Dropping water levels in the Ogallala aquifer are probably less closely associated with the decline of cottonwoods although there may be a relationship between the aquifer and the continued presence of water in the alluvial layer.

Further compounding the dieout problem is the lack of regeneration noted in the survey. This is probably due to the lack of a moist, bare seedbed and the destructive effects of grazing by cattle (Crouch, 1979). There will be very few new stands of cottonwood developing. Those that do develop will probably do so in conjunction with a major flood. Their ultimate fate will be determined by the same factors now causing widespread mortality.

The future existence of the riparian cottonwoods along the Beaver River is tenuous. The past rate of irrigation development is probably tapering off. However, development is continuing and as long as water is available and economical to pump, irrigation will continue. This long-term stress on cottonwood will continue to intensify and the decline will spread as water

levels and surface flows are further reduced. Rising demands for food, the high value of irrigated crops, and the need to maximize production and profits of farms will preclude any wide-scale remedial changes in irrigation practices in the near future.

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Figure 1. Plot locations along the Beaver River and tributaries in Texas County, Oklahoma, June, 1981.

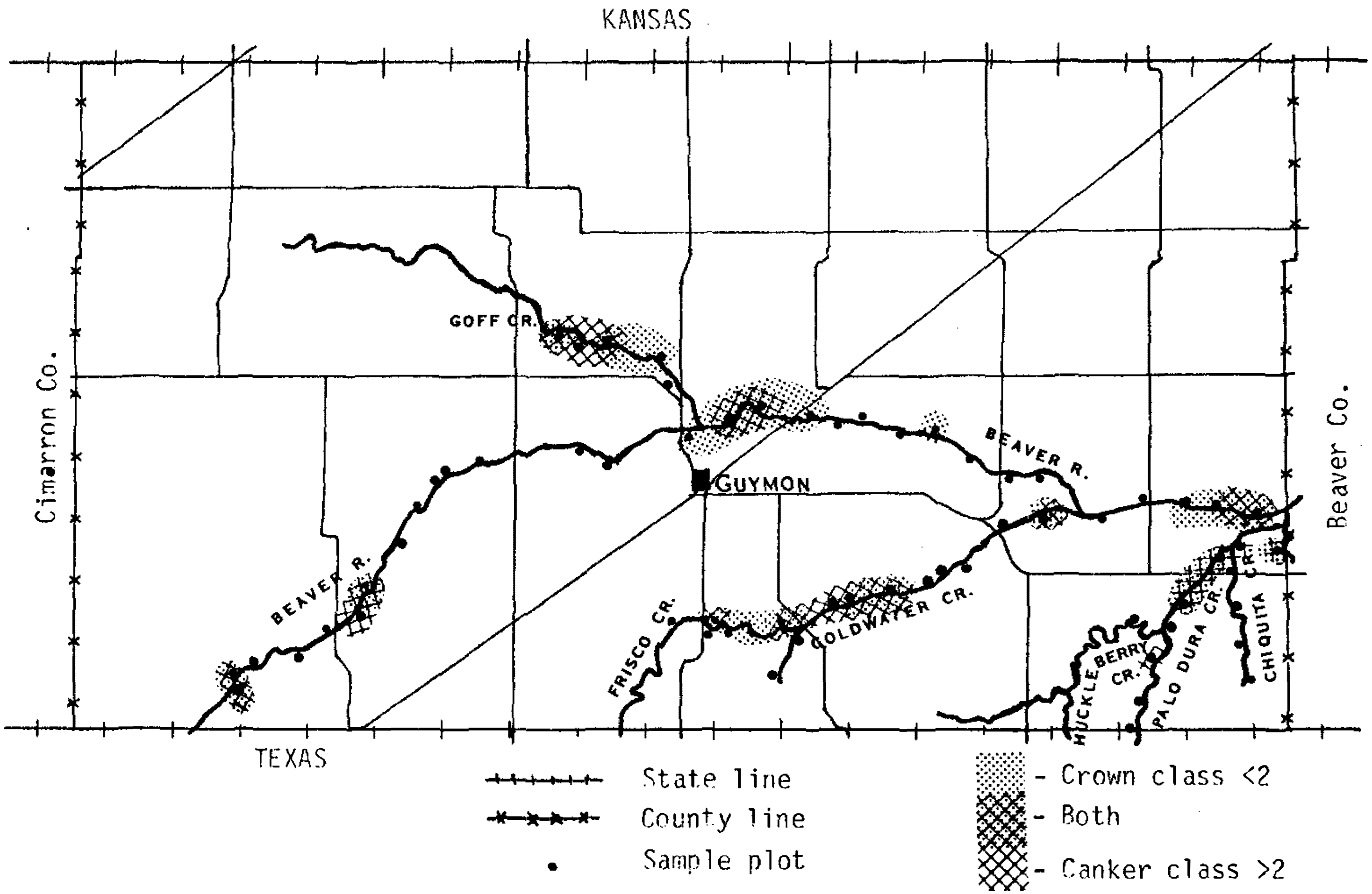

Figure 2. Number of trees occurring in 2" dbh classes.

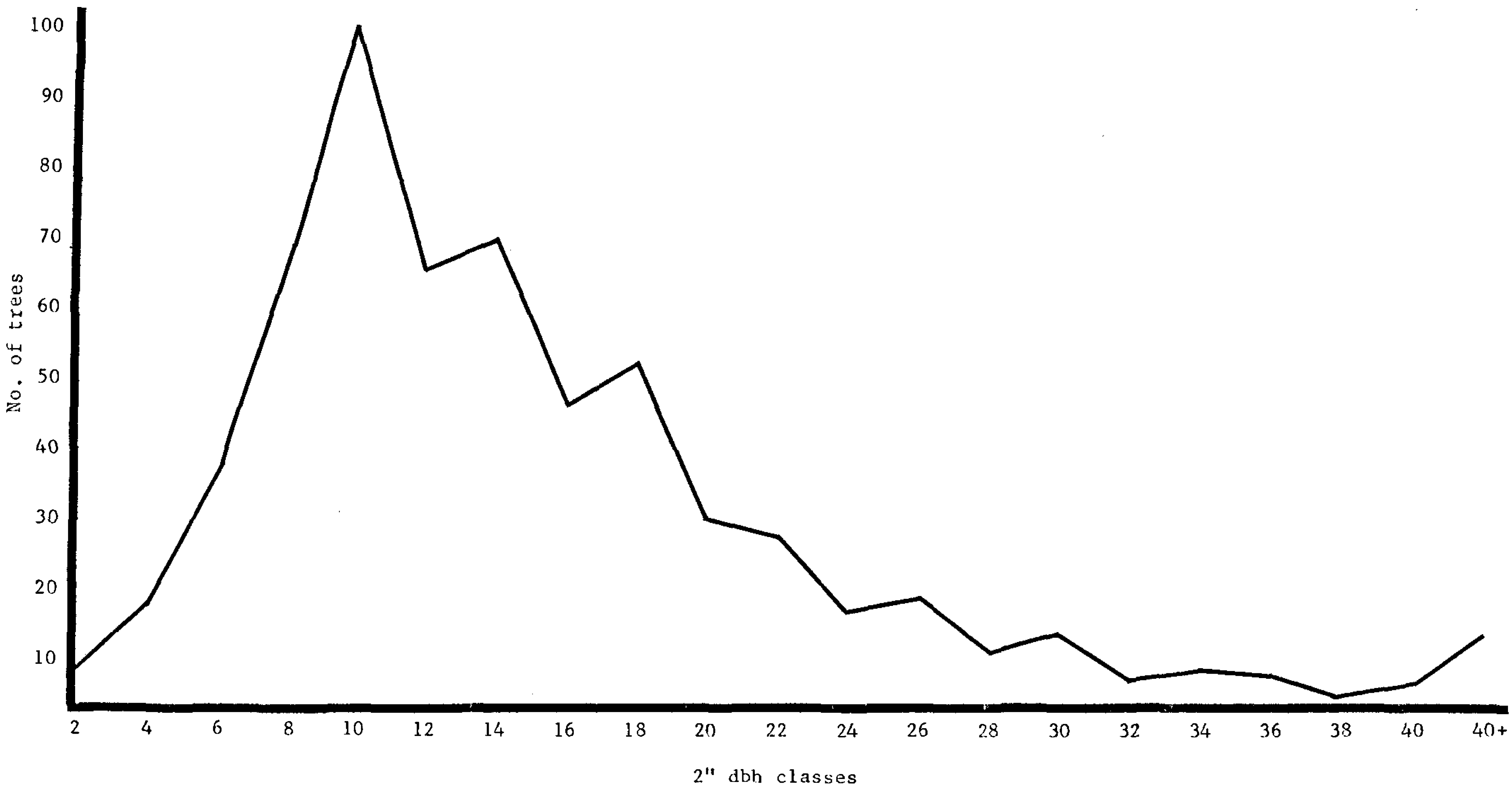

Figure 3. Percent of declining, cankered and all trees occurring in 10" dbh classes.

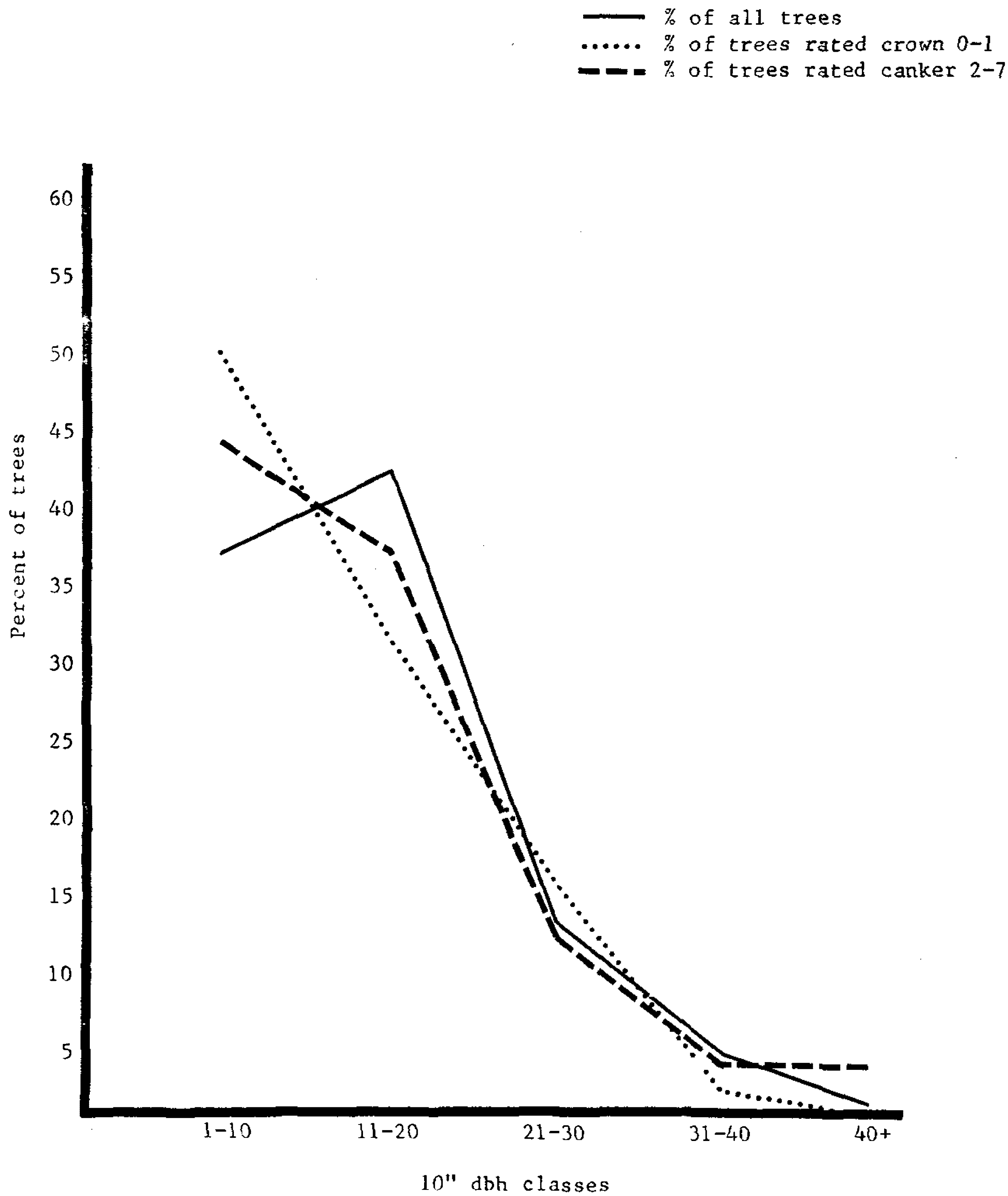

Figure 4. Sapwood staining associated with cottonwood cankers, Texas Co., Oklahoma, June 1981.

Table 1. Crown condition of cottonwood in 10-tree plots along the Beaver River and tributaries in Texas County, OK.

Rating	Description
0	Dead tree with bark intact
1	≥50% of crown dead
2	<50% of crown dead
3	Healthy crown and foliage

Table 2. Canker rating of cottonwood in 10-tree plots along the Beaver River and tributaries in Texas County, OK.

Rating	Description
0	No cankers present
1	Branch cankers only
2	Basal cankers only
3	Branch & basal cankers (1 & 2)
4	Bole cankers above DBH
5	Bole cankers above DBH and branch cankers (4 & 1)
6	Bole cankers above DBH and basal cankers (4 & 2)
7	Bole cankers above DBH, basal cankers and branch cankers (4 & 2 & 1)

Table 3. Distribution of plots according to mean crown and canker ratings.

Mean Crown Rating	# Plots	% Plots
0-2	26	41
2-3	37	59

Mean Canker Rating	# Plots	% Plots
2-7	25	40
0-2	38	60

Table 4. Distribution of trees according to crown and canker ratings.

Crown Rating	# Trees	% Trees
0 or 1	141	22
2 or 3	489	78

Canker Rating	# Trees	% Trees
2-7	193	31
0 or 1	437	69

Table 5. Summary distribution of plots with mostly declining crown and/or mostly cankered trees.

Plots with mean crown rating <2 only	Plots with mean crown rating <2 and canker rating >2	Plots with mean canker rating >2 only
6 (21%)	17 (61%)	5 (18%)

Table 6. Distribution of solitary plots vs. plots in geographic clusters with mostly declining crown and/or mostly cankered trees.

	Group of 2 or more plots	Solitary	Total
Crown rating <2	17 (77%)	5 (23%)	22
Canker rating >2	16 (80%)	4 (20%)	20

Table 7. Fungi isolated and frequency of isolation.

Fungus	Times Isolated	Location
Alternaria sp.	1	Cytospora "sporehorns"
Cephalosporium sp.	2	Stem
Coniothyrium sp.	3	"Sporehorn", stem
Cylindrocarpon sp.	3	Branch, stem
Cytospora sp.	8	Branch, stem, spore-horn"
Fusarium sp.	3	Branch, stem
Verticillium sp.	2	Branch, stem
Unknown sp.	4	Branch
	26	

APPENDIX I

SOIL RELATED DATA AND CONCLUSIONS CONCERNING COTTONWOOD MORTALITY SURVEY IN TEXAS COUNTY, OKLAHOMA - JUNE, 1981

Kurtis L. Atkinson, Staff Forester
Oklahoma Forestry Division

The Alexandria Field Office of the U.S. Forest Service, in cooperation with the Oklahoma Forestry Division, and support of the OSU Extension Service, surveyed mortality of Eastern Cottonwood (Populus deltoides) in Texas County, Oklahoma, June 15-20, 1981. Approximately 75 sample points, located at two mile intervals along the Beaver River and major tributaries, were surveyed on-site for tree size and condition, and the presence of Cytospora cankers on the cottonwood.

The survey involved looking at many factors and how each has contributed to the severe mortality and decline of the cottonwood in certain areas. A sampling scheme was developed to see if soil type and nutrient content were factors in the decline. Soil samples were taken using a soil probe on every fifth sample point, beginning with plot number three. Therefore every plot number ending in "3" or "8" required a soil sample. If no trees were present at a point, the sample was taken at an adjacent point.

At each plot, two separate samples were taken: one from an area of healthy trees, and one from an area of dead and dying trees, if available. If soil was a factor, there should be consistent differences between the soil analyses.

Ten paired samples were selected and routine soil analysis performed at the Soils Laboratory of Oklahoma State University. The results were as follows:

Table 1. Soil Analysis of paired samples for Cottonwood mortality survey in Texas County, Oklahoma.

	pH		lbs.N		lbs.P		lbs.K		
PLOT #	*D&D	H	D&D	H	D&D	H	D&D	H	Soil Type ***
3	7.8	8.3	36	3	1	1	588	228	Lincoln
8	8.0	8.2	28	9	28	37	905	626	Lincoln
14	8.3	8.5	10	8	1	37	636	484	Sweetwater
18	8.4	8.3	7	40	5	2	334	524	Sweetwater
23	8.3	8.3	4	13	46	19	227	129	Lincoln
27	8.0	8.1	11	7	1	0	799	605	Sweetwater
33	8.0	8.1	3	29	15	24	161	208	Sweetwater
38	8.0	8.2	12	5	1	1	765	779	Sweetwater
48	8.1	7.9	7	25	1	0	598	461	Spur
68	7.5	8.0	2	1	26	20	363	294	Sweetwater
Averages	8.04	8.19	12	14	12.5	14.1	538	434	
Ranges	7.5-8.4	7.9-8.5	2-36	1-40	1-46	0-37	161-905	129-779	
**19	-	7.7	-	96	-	5	-	1000	Sweetwater

* D&D - Dead and dying, H - Healthy
** Sample 19 taken from healthy stand adjacent to alfalfa field.
*** Soil types adjacent to alluvium soils along rivers.

Analyzing the averages for pH, and N, P, and K content between dead and dying and healthy cottonwood stands, there appears to be no statistical difference between the soils which would play an important factor in the mortality problem.

The pH of the soils in this general area is slightly higher than the preferred 3.6-7.5 range noted by Williston and LaFayette. However, it is obviously not a pre-condition to healthy cottonwood stands, as the average pH for the healthy group is higher than the dead and dying group, and both exceed 7.5.

Sample #19 was taken in a very healthy stand of trees adjacent to an alfalfa field. Alfalfa is irrigated throughout the growing season and is also fertilized. The high levels of nitrogen and potassium in this soil are indicative of the leaching by irrigation water from the alfalfa field downhill into the cottonwood. Condition of the trees is directly attributable to increased moisture and nutrient availability, as the demarcation was obvious.

Summary

Soil types and nutrient content were very similar between healthy stands and unhealthy stands of cottonwood. Cottonwood commonly invades sandy soils along drainages, which are among the first to dry out during periods of drought. In general the decline appears to be initiated by moisture stress, rather than any major difference in soil type, although the droughtiness of the soil contributes greatly.

The cottonwood in Texas County may benefit greatly from supplemental irrigation and possible fertilization to increase nutrient levels and lower pH. This is recommended only for high value areas where feasible.

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APPENDIX II

WATER RELATED DATA AND CONCLUSIONS
Concerning Cottonwood Mortality Survey
In Texas County, Oklahoma - June, 1981

Kurtis L. Atkinson, Staff Forester
Oklahoma Forestry Division

An integral part of the cottonwood mortality survey involved the effect that a falling water table and low precipitation may have had on the tree population. The origianl theory was that moisture stress caused by sub-normal rainfall and the lowering of the water table due to proliferation of irrigation wells created an environment which allowed cytospora cankers to invade and overcome the tree's defenses causing mortality.

The Oklahoma Water Resources Board provided records of water well levels from 1966 through 1980 as monitored by the U.S. Geological Survey. Well locations were selected from these records, primarily along the Beaver River and its tributaries. Depth to water readings in these wells were recorded and plotted to show the changes over the past 15 years.

In Texas County, 19 wells were selected for in-depth study, although 4 of these were omitted because monitoring was discontinued. Of the 15 remaining, 12 were in the Ogallala formation, and 3 were in alluvium formations. Four sites were selected in Beaver County, all in alluvium formations.

Actual water level depths are listed in Table 1. Graphs of these readings follow in Figure 1. Nine of the 12 Texas County wells in the Ogallala show significant and steady declines in the water level. Three remained fairly stable over the period, although fluctuations are evident. The alluvium sites showed much less change but often fluctuated dramatically from year to year. A one year's decline of only a few feet may be enough in some cases to cause tree decline.

Water well readings were taken most frequently in January. The graphs do not reflect the increases or decreases through the growing season. One would surmise that substantial decreases would result during the summer when heavy irrigation and low rainfall occur. The January readings could conceivably reflect a certain amount of recharge, although the recharge of the Ogallala occurs at a very slow rate.

Alluvium soils are sandy or gravelly in texture, and dry out rapidly. Most of the cottonwood in this area occurs on soils of this type. Rainfall infiltrates rapidly, providing little runoff. Tree roots extend downward many feet in search of moisture. During the growing season, water levels will fluctuate faster than tree roots can respond, causing severe moisture stress during periods of drought. The effect that the drawdown of the Ogallala aquifer has on the alluvium aquifer and on the cottonwood trees is a matter of conjecture at this point. As subsurface water levels fall, water infiltration may be faster and lost to tree roots more quickly. This appears to be the case, as local residents indicate the smaller creeks do not flow nearly as often as five or ten years ago.

Precipitation records were examined to determine whether the last 3 to 5 years were substantially drier than normal. Records were obtained at the Corps of Engineers facility at Optima Lake Dam in conjunction with the Forestry Division's vegetative efforts in the recreation areas.

Table 2. Precipitation at Corps Weather Station, Optima Lake.

Month	1974	1975	1976	1977	1978	1979	1980	1974-80 Avg.	Normal	1974-80 % of norma
Jan.	T	.29	-	.15	.05	.02	1.58	.30	.32	94
Feb.	T	.50	.03	.09	1.02	.01	.26	.27	.54	50
Mar.	1.38	.12	.45	.29	.06	.89	1.84	.72	.79	91
Apr.	.27	2.16	4.19	1.49	.54	2.47	1.32	1.77	1.44	123
May	.42	2.76	1.73	5.98	4.21	.59	3.64	2.76	2.57	107
June	2.28	1.82	.16	.44	3.53	2.06	.74	1.58	2.33	68
July	.70	1.67	3.37	2.08	.90	6.32	-	2.15	2.35	91
Aug.	3.29	.36	.18	4.01	1.84	.54	2.13	1.76	2.17	81
Sept.	2.21	.17	1.65	1.40	2.02	.54	-	1.14	1.83	62
Oct.	1.90	-	.28	-	.11	3.39	.26	.85	1.36	60
Nov.	.06	2.54	T	.14	.87	.22	.43	.61	.66	92
Dec.	.23	-	T	.08	.02	-	.68	.14	.58	24
TOTALS	12.74	12.39	12.04	16.15	15.17	17.05	12.88	14.05	16.94	
% of Normal	75	73	71	95	89	101	76	83	-	

Table 2 indicates that 1974-1976 were relatively dry, with only 71-75% of normal precipitation. The next 3 years were near normal. Annual precipitation for the period 1974-80 averaged only 83% of normal. 1980 was extremely hot and dry, and may have contributed greatly to the decline of the trees. However, many trees had started to decline in 1978 and 1979 according to local residents.

Hot dry weather during the growing season, such as 1975, 1976, 1979 and 1980 has apparently prevented natural regeneration from becoming established, as very few seedling or sapling size trees are present in and around the older stands. Because cottonwood is normally an invader species, occupying sandy, exposed sites, and because the Panhandle area has historically low rainfall, other factors have contributed to the lack of regeneration besides low rainfall. One major change occurring primarily in the last 10 years is the tremendous increase in the number of irrigation wells. The "drought" appears to have been accentuated by the falling water table, a synoptic effect which causes faster drying of the soil surface and contributes to tree mortality.

Summary

Periodic drought has plagued the Panhandle historically, and is not new. Many cottonwoods have withstood more than one of these dry periods. A new factor which has entered the picture is the impact of irrigation wells on the water table, and the subsequent impact on tree survival and reproduction.

Rising demands for food, and shrinking farmland areas will require continued use of irrigation water. Water levels will continue to fall until the source dries up, fuel prices become prohibitive, or water transfer becomes feasible. Until that time, cottonwood trees will have to be supported by rainfall or supplemental irrigation.

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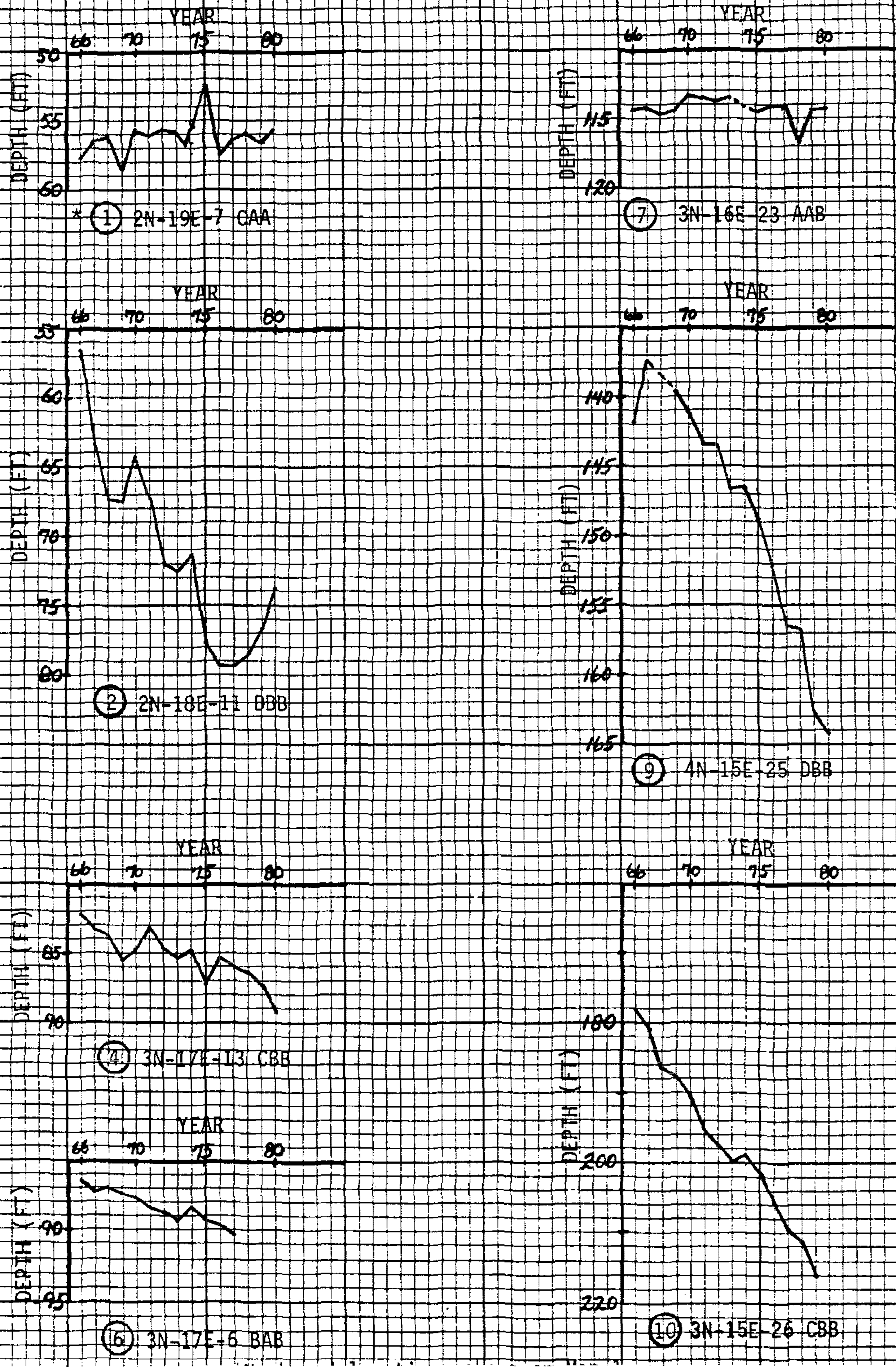
FIGURE 1. WATER LEVEL CHANGES 1966-1980

SELECTED TEXAS COUNTY WELLS, OGALLALA FORMATION



TEXAS COUNTY WELLS, OGALLALA FORMATION
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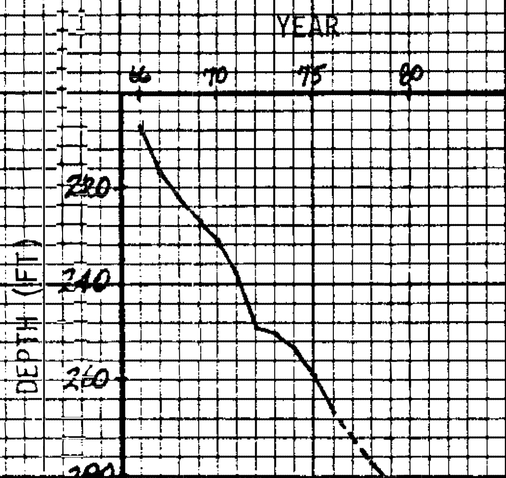
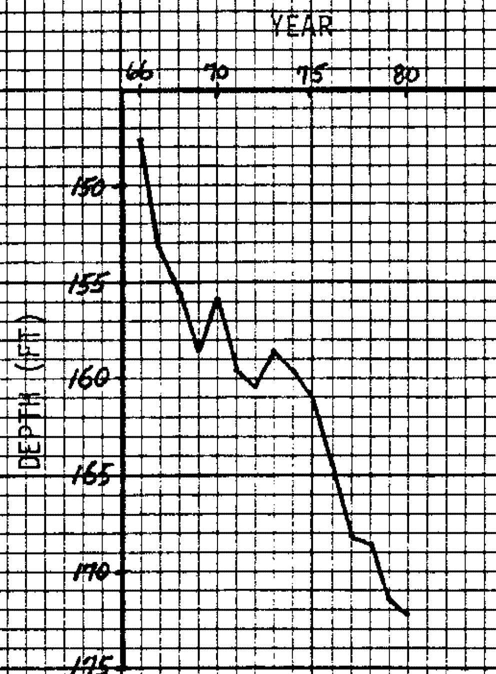
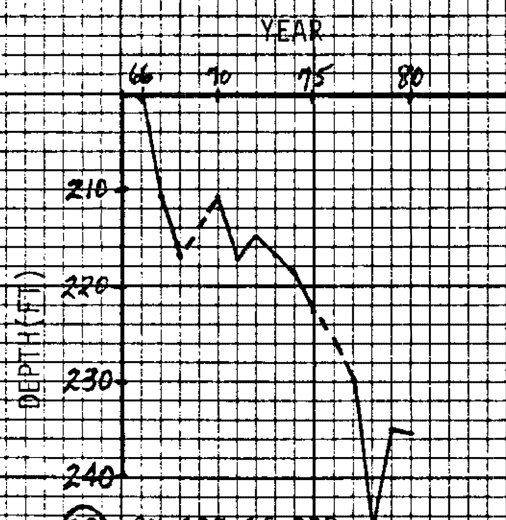


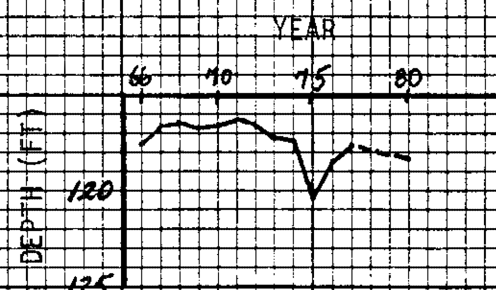
(11) 2N-15E-9 BCB



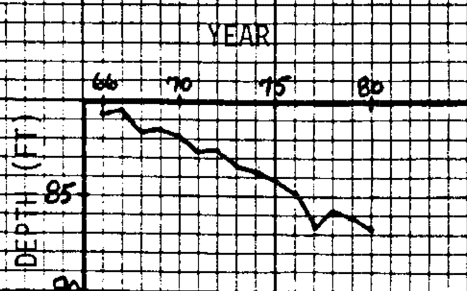
(16) 2N-11E-34 CCB



(12) 2N-13E-16 BBB



(17) 1N-11E-22 DDC

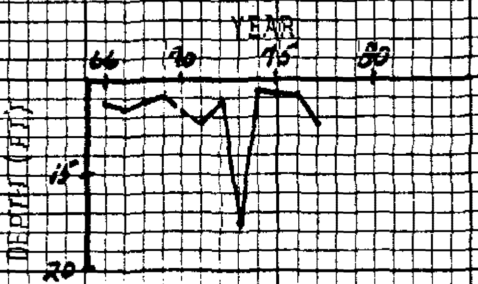


(15) 1N-12E-8 DCD

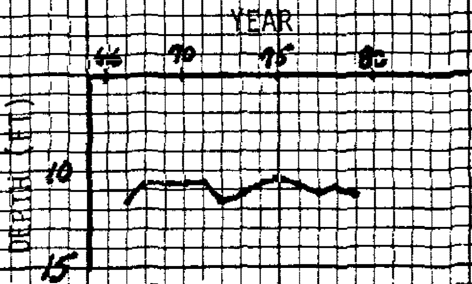
WATER LEVEL CHANGES 1966-1980
ALLUVIUM FORMATION

TEXAS COUNTY

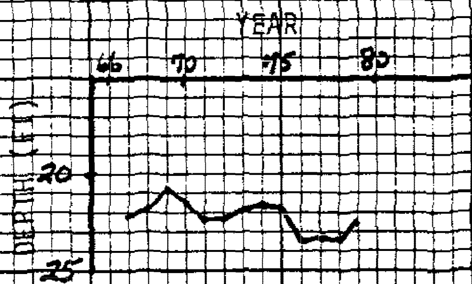
BEAVER COUNTY



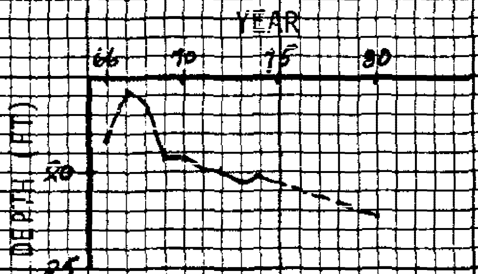
5 2N-17E-11 BDD



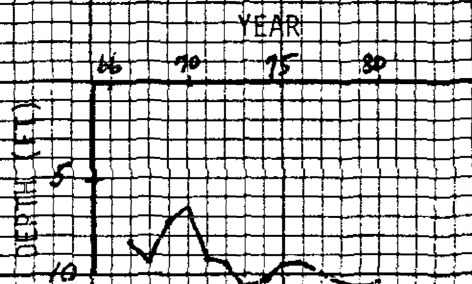
20 4N-22E-13 ABB



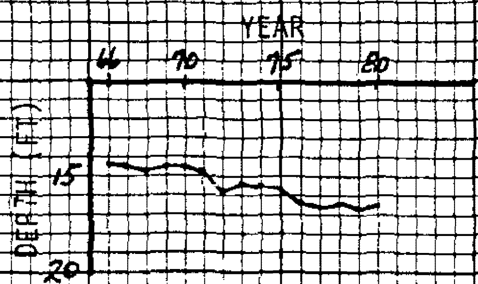
21 4N-24E-24 CCC



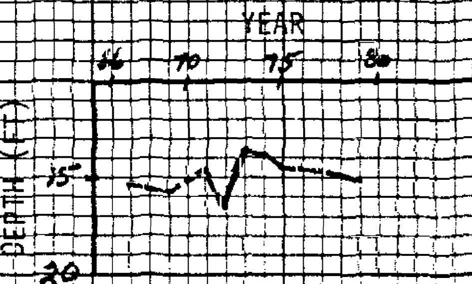
18 2N-12E-33 BAB



22 4N-28E-26 DDA



19 3N-16E-16 ABB



23 4N-28E-34 BBB

FIGURE 3— CHANGE IN WATER WELL LEVELS
(in feet)
Cimarron County 1967-1972

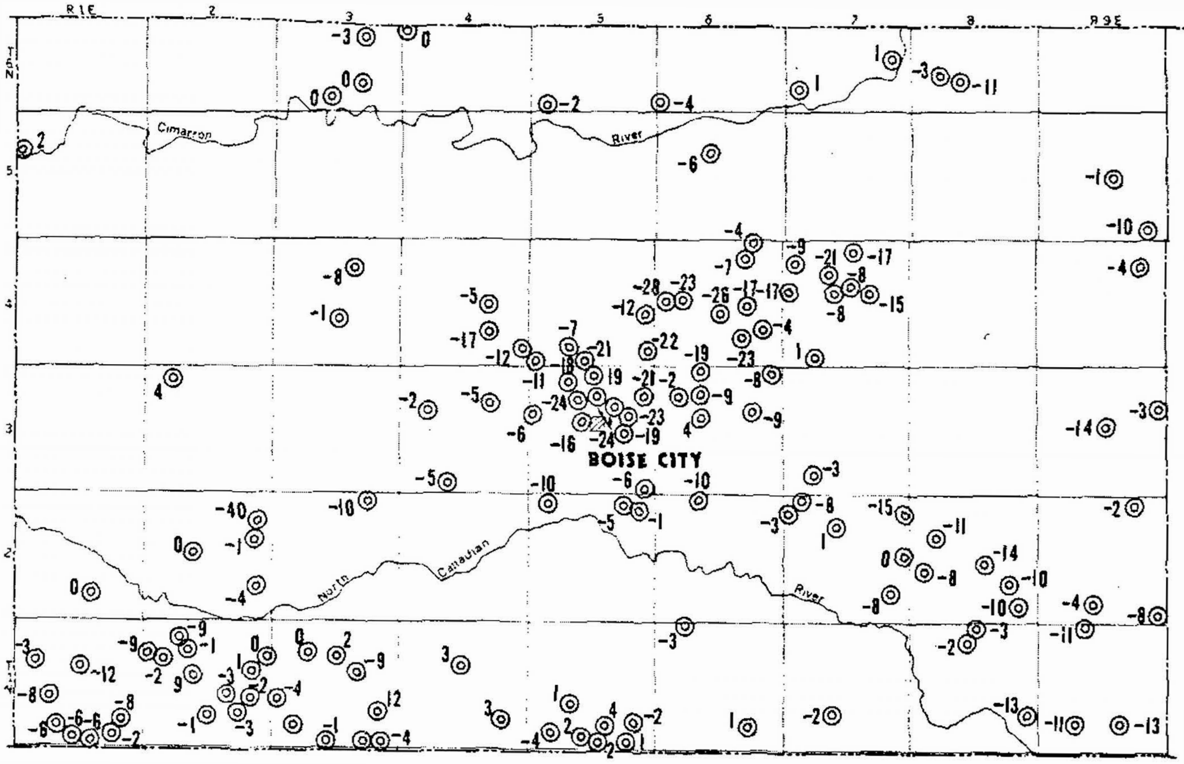
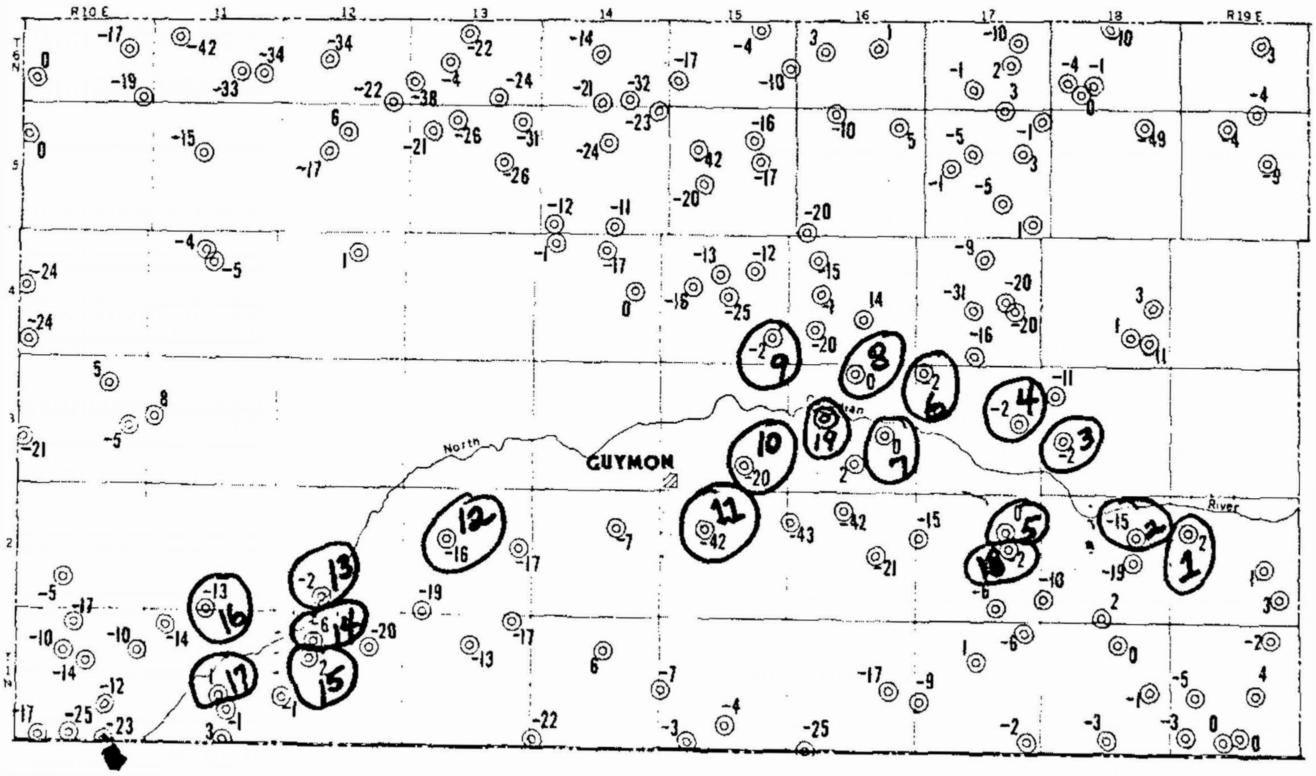


FIGURE 4— CHANGE IN WATER WELL LEVELS
(in feet)
Texas County 1966-1972



from the Ogallala if it is saturated. The quality of the water is generally good.

GROUND WATER USE

Use of ground water in Region XII has shown a great increase over the past six years. (See "Six-Year Summary of Reported Water Use.") Reported use in 1971 had increased about 156 percent over the amount reported in 1966. Reported ground water use in Cimarron, Texas, and Beaver Counties totalled 413,747 acre-feet in 1971, which accounts for more than 50 percent of the State's total reported ground water use.

Of the 413,747 acre-feet total, 406,494 acre-feet were used to irrigate 251,078 acres of land, most of which was planted to corn, wheat, and grain sorghum. Land irrigated by ground water in the Panhandle accounts for 55 percent of the total State reported land irrigated by ground water. The remaining 7,253 acre-feet were used for municipal, industrial, and other purposes. Ground water accounts for almost 99 percent of water reported used in Region XII.

DEVELOPMENT OF IRRIGATION

Pumpage of irrigation began in the 1930's with fewer than 30 wells. Development of irrigation wells continued at a slow but steady rate until 1964 when the rate increased very rapidly in Cimarron and Texas counties as shown in Figure 1. In 1960 there were approximately 400 wells in the Panhandle being used to irrigate an estimated 80,000 acres ; by 1965 the number had more than doubled with about 975 wells irrigating 220,000 acres. In 1971 there were a reported 1,846 wells irrigating 344,040 acres in the three Panhandle counties with 236, 715, and 895 irrigation wells in Beaver, Cimarron, and Texas counties, respectively.

The greatest concentration of high-capacity wells occurs in the areas south of Guymon, north of Goodwell, and in the northwestern part of Texas county. In Cimarron county, closely spaced wells occur in the Boise City area and in the southwestern corner of the county near Felt. The distribution of wells can be noted Figures 2, 3, and 4.

EFFECT OF PUMPAGE ON WATER LEVELS

Wells that are closely spaced and pumped for significant periods of time at high rates, create a cone of depression around the pumped wells. As these cones extend outward, they may overlap each other thereby reducing the quantity of water available to both wells. This situation has become fairly common in the heavily developed areas of the Panhandle, and the quantity of water pumped annually from these areas has been exceeding the annual recharge to the aquifer.

Significant declines in water levels have taken place in most of the areas that have been heavily developed for irrigation. The greatest declines have been in the

FIGURE 2— CHANGE IN WATER WELL LEVELS
(in feet)
Beaver County 1967-1972

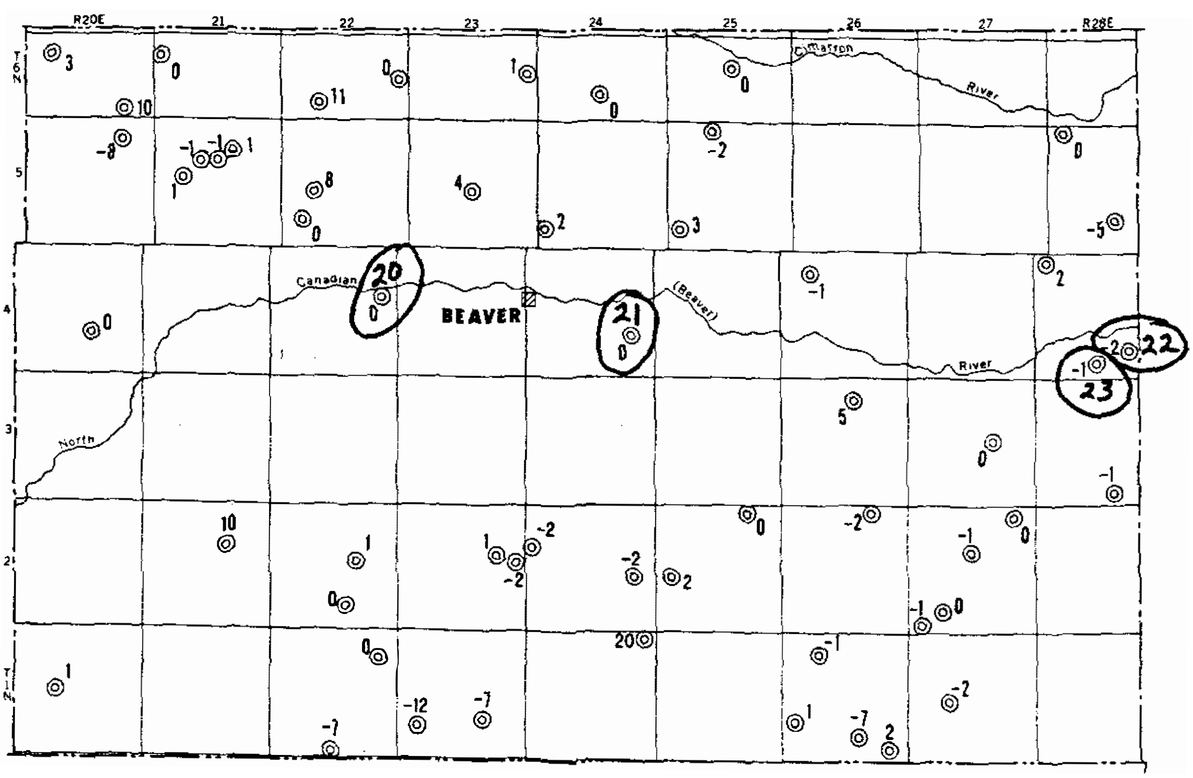


TABLE 1. Depth in feet to Water Level in Selected Wells, Texas and Beaver Counties in Oklahoma, Ogallala and Alluvium Formations. *

Well #	County	Location	1939	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Aquifer	1966-1980 Rise (+) or Fall (-) in Depth (ft.)
1	Texas	2N-19E-7 CAA	-	57.7	56.4	56.08	58.59	55.78	56.05	55.73	55.9	55.71	52.25	57.49	56.32	55.99	56.76	55.85	Ogallala	+1.85
2	"	2N-18E-11 DBB	-	56.6	63.35	67.11	67.44	64.15	67.17	71.99	72.57	71.28	77.8	79.17	79.18	78.75	76.72	73.91	"	-17.31
3	"	3N-18E-20 BBB	-	68.5	69.34	69.37	72.54	69.8	70.21	70.43	69.34	—	—	Discontinued			—	—	"	—
4	"	3N-17E-13 CBB	-	82.1	83.21	83.73	85.5	84.76	83.02	84.7	85.27	84.91	87.09	85.38	86.01	86.45	87.29	89.14	"	-7.04
5	"	2N-17E-11 BDD	-	11.2	11.48	11.18	10.99	—	12.18	11.05	17.74	10.65	10.77	11.87	12.40	—	—	—	Alluvium	-1.2
6	"	3N-17E-6 BAB	-	86.4	87.18	86.97	87.49	87.92	88.39	88.87	89.12	88.35	89.33	89.66	90.2	—	—	-	Ogallala	-3.8
7	"	3N-16E-23 AAB	-	114.3	114.13	114.68	114.56	113.36	113.42	113.82	113.55	—	114.58	114.09	114.09	116.93	114.34	114.25	"	+.05
8	"	3N-16E-3 BBC	-	83.1	83.5	83.57	84.04	82.55	83.02	83.16	83.3	82.05	82.59	82.43	—	—	—	—	"	—
9	"	4N-15E-25 DBB	-	141.9	137.49	-	139.86	141.05	143.34	143.43	146.62	146.49	148.97	152.1	156.51	156.69	162.58	164.12	"	-22.22
10	"	3N-15E-26 CBB	-	178.1	181.24	186.41	187.95	190.11	195.5	197.88	199.9	198.87	201.73	205.93	209.52	211.18	216.1	—	"	-38.0
11	"	2N-15E-9 BCB	-	207.4	216.69	222.21	227.08	231.22	238.0	248.89	249.4	253.29	259.3	266.68	—	276.94	280.66	—	"	-73.26
12	"	2N-13E-16 BBB	-	199.0	210.89	216.64	—	210.42	217.32	214.93	216.76	218.45	222.18	-	229.89	245.53	234.84	235.53	"	-36.53
13	"	2N-12E-33 BAB	-	18.2	15.74	16.49	19.3	19.22	19.99	20.0	20.43	20.12	—	—	—	—	—	22.14	Alluvium	-3.94
14	"	1N-12E-8 AAC	-	30.3	31.22	—	-	32.68	33.62	35.98	—	-	Discontinued			—	—	-	Ogallala	—
15	"	1N-12E-8 DCD	-	80.8	80.49	81.79	81.5	81.95	82.74	82.64	83.26	83.7	84.08	84.9	86.77	85.92	86.07	86.73	"	-5.93
16	"	2N-11E-34 CCB	-	147.7	153.22	155.56	158.59	155.9	159.65	160.36	158.55	159.6	161.03	164.55	168.02	168.56	171.45	172.04	"	-24.34
17	"	1N-11E-22 DDC	-	117.7	116.55	116.45	116.84	116.61	116.29	116.65	117.1	117.27	120.27	118.47	117.62	-	-	118.12	"	-.42
18	"	2N-17E-14 ABB	-	11.2	12.21	12.4	10.55	12.45	13.15	12.75	—	—	Discontinued			—	—	-	Alluvium	—
19	"	3N-16E-16 ABB	-	14.2	14.49	14.76	14.56	14.58	14.84	15.86	15.34	15.55	15.79	16.3	16.50	16.38	16.7	16.5	"	-1.7
20	Beaver	4N-22E-13 ABB	—	—	11.53	10.87	10.79	10.8	10.73	11.55	11.19	10.75	10.59	10.85	11.1	10.98	11.11	—	Alluvium	+.42
21	"	4N-24E-24 CCC	22.5	—	22.09	21.96	20.88	21.58	22.19	22.34	21.94	21.64	21.87	23.44	23.25	23.39	22.51	-	"	-.42
22	"	4N-28E-26 DDA	-	—	8.09	9.32	7.05	6.5	9.25	9.59	10.77	10.22	9.52	9.65	—	10.38	10.5	10.29	"	-2.2
23	"	4N-28E-34 BBB	14.86	—	15.29	15.78	15.82	—	14.64	16.65	13.72	13.91	14.44	14.55	—	14.96	15.08	—	"	+.21

* Source: Selected Water Level Records For Oklahoma, 1966 through 1980, U.S. Geological Survey in Cooperation with the Oklahoma Water Resources Board.
Appraisal of the Water and Related Land Resources of Oklahoma, Region 12, 1973, Oklahoma Water Resources Board.

REPORT NO. 81-2-27
ALEXANDRIA FIELD OFFICE

3430
SEPTEMBER 1981

EVALUATION OF COTTONWOOD DECLINE AND MORTALITY IN THE RIPARIAN WOODLAND OF THE BEAVER RIVER IN TEXAS COUNTY, OKLAHOMA, 1981

Prepared by: Dale Starkey
Pathologist

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